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HERMANN CARL VOGEL

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ADDRESS OF THE RETIRING PRESIDENT OF THE SOCIETY, IN AWARDING THE BRUCE MEDAL TO GEHEIMER OBER-REG. RATH PROFESSOR DR. HERMANN CARL VOGEL.

By SIDNEY D. TOWNLEY.

At the close of another fiscal year in the history of the Astronomical Society of the Pacific it becomes my pleasant duty, as your retiring President, to review briefly the past progress of the Society and to make public announcement of the sixth award of the Bruce Gold Medal.

This Society was founded February 7, 1889, as the result of the co-operation between amateur and professional astronomers in observing the total solar eclipse on New Year's day of that year. The Society was designed to be popular in the best sense of the word, and its progress for several years was very rapid. Later, however, a slight retrograde movement set in, but, as in the case of the planets, this did not last long, and we are happy to state that the Society is again moving with forward motion. The membership, though not large, is of a solid, permanent character, and the *Publications* of the Society now hold a recognized place in astronomical literature. Seventeen volumes of the *Publications* are now complete, and the Society's library contains fourteen hundred books and about the same number of pamphlets. Through the liberality of generous friends the Society now possesses an endowment fund, including the Life Membership Fund, of nearly $17,000; the interest from which is used for various purposes,—such as the bestowal of the Bruce Gold Medals, of the Donohoe Comet-Medals, for additions to the library, etc.

In 1897, the late CATHERINE WOLFE BRUCE, of New York, gave to the Society a fund of $2,750, of which $250 was to be used for the purchase of a gold medal to be awarded, regardless of race or sex, for distinguished services to astronomy. The remaining $2,500 was to be invested, and the interest therefrom used for the bestowal of other medals, not oftener than once a year. The directors of six of the largest and most prominent observatories in the world—Berlin, Harvard, Greenwich, Lick, Paris, and Yerkes—are each asked to nominate three astronomers as worthy to receive the medal, and from the persons thus nominated the medalist is chosen by the directors of the Society.

The first award of the medal was made to the eminent American astronomer, Professor SIMON NEWCOMB; the second award to one of Germany's distinguished sons, Professor ARTHUR AUWERS; the third award to an Englishman who attained eminence far away from his native isle, Sir DAVID GILL, Director of the Cape of Good Hope Observatory; the fourth award to Professor GIOVANNI VIRGINIO SCHIAPARELLI, Director of the Observatory at Milan, and Italy's most renowned astronomer; the fifth award to Sir WILLIAM HUGGINS, another of England's famous astronomers, who is still busily engaged in scientific researches at the age of eighty-two; and now it gives me great pleasure to publicly announce that the sixth award of the medal has been made to another of the eminent sons of Germany, Professor HERMANN CARL VOGEL, Director des Astrophysikalischen Observatorium zu Potsdam.

Professor VOGEL has been connected with the Astrophysical Observatory at Potsdam ever since it was established in 1874, and his work has therefore been almost entirely along the line of the new astronomy, or astrophysics. He now stands with our fifth medalist, Sir WILLIAM HUGGINS, as one of the pioneer workers in this highly interesting branch of astronomy, and his many published writings, only a portion of which are to be found in the volumes of the Astrophysical Observatory, will stand as a lasting monument to his industry, ability, and constant devotion to the queen of all the sciences, astronomy.

Our medalist was born in Leipsic March 4, 1842. His education was obtained at the University of Leipsic, and he became assistant in the Leipsic Observatory in 1864. From 1870 to 1874 Doctor VOGEL was director of Herr von BULOW's private observatory at Bothkamp, near Kiel. From 1874 to

1882 he was associated with the commission which had in charge the building of the Astrophysical Observatory at Potsdam, and in the latter year, when this magnificent institution was turned over to the Government by the commission, Doctor VOGEL became its first director, and still remains in that position.

The observatory at Potsdam was built and is maintained by the Prussian Government. It was at first indirectly connected with the University Observatory at Berlin, but it now has no connection with any educational institution, although some of the astronomers of the observatory lecture at the University of Berlin.

The observatory is located on the summit of a hill, amid spacious, heavily wooded, and well-kept grounds, just outside of Potsdam, at a distance of about fifteen minutes' walk from the railway station. The general construction of the observatory may be seen from the illustration presented herewith.[1] The principal instruments of the original observatory are three refractors,—one of 30 centimeters (12 inches) aperture, objective by SCHROEDER, mounting by REPSOLD, in the central dome; one of 21 centimeters (8 inches) by GRUBB, in the western dome, used chiefly for the observation of sun-spots; and a 13-centimeter (5 inches) telescope by STEINHEIL, in the eastern dome, used for spectroscopic observations of the Sun and for photometric work. It should be stated that the Potsdam Observatory was intended originally for solar work, and it was indeed formerly called the Sonnenwarte, or solar observatory, as distinguished from a Sternwarte, or star observatory. One of the rooms of the observatory contains a very large and accurately constructed spectrometer, by BAMBERG, which is used for study of the solar spectrum, the rays of light from the Sun being brought to the collimator in a horizontal direction by means of a heliostat. The rooms of the observatory contain many smaller instruments and pieces of apparatus.

In 1889 it was decided by an international conference which met in Paris to take up, by co-operation among a number of observatories, the almost herculean task of photographing the entire sky and making catalogues and charts of the stars contained upon the plates obtained. The Potsdam Observatory engaged to take part in this work, and was assigned the zone lying between 31° and 40° of north declination. For this purpose a new photographic refractor of 45 centimeters (13 inches) aperture was provided and mounted in a dome detached from the main building. The instrument is in fact a doublet, a visual telescope of 23 centimeters (9 inches) being provided for the purpose of guiding the photographic telescope.

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[1] The photographs from which this cut and the one of Doctor VOGEL were made were kindly loaned by Prof. LEUSCHNER. Another view of the observatory and a short descriptive article by Prof. LEUSCHNER may be found in Volume IV of these Publications.

Again in 1900 a very material addition was made to the equipment of the observatory by the acquisition of a great refractor having a photographic objective of 80 centimeters (31.5 inches) and a focal length of 12 meters (39 feet), and also a visual telescope with aperture of 50 centimeters (20 inches) and focal length of 12½ meters (41 feet). This instrument is used chiefly for the determination of the velocities of stars in the line of sight, and is located in a dome situated on a second hill at some little distance from the main building. The unfinished dome may be seen in the illustration.[1]

Besides Director VOGEL there are a number of astronomers and assistants connected with the Potsdam Observatory, and an atmosphere of intense scientific activity prevails there. Fourteen well-filled quarto volumes have been issued in the regular series of publications of the Observatory. The investigations printed in these volumes cover a considerable range of problems in astrophysics. Among these may be mentioned observations of sun-spots, investigations of the solar spectrum, studies of the spectra of the planets and the fixed stars, photographic observations of the velocities of the stars, observations of variable stars, photometric determinations of stellar magnitudes, etc. In addition to the regular series of publications three volumes have been issued giving the results of the work undertaken in connection with the international plan to photograph the entire heavens, mention of which has already been made. These volumes contain the photographic magnitude and ap-

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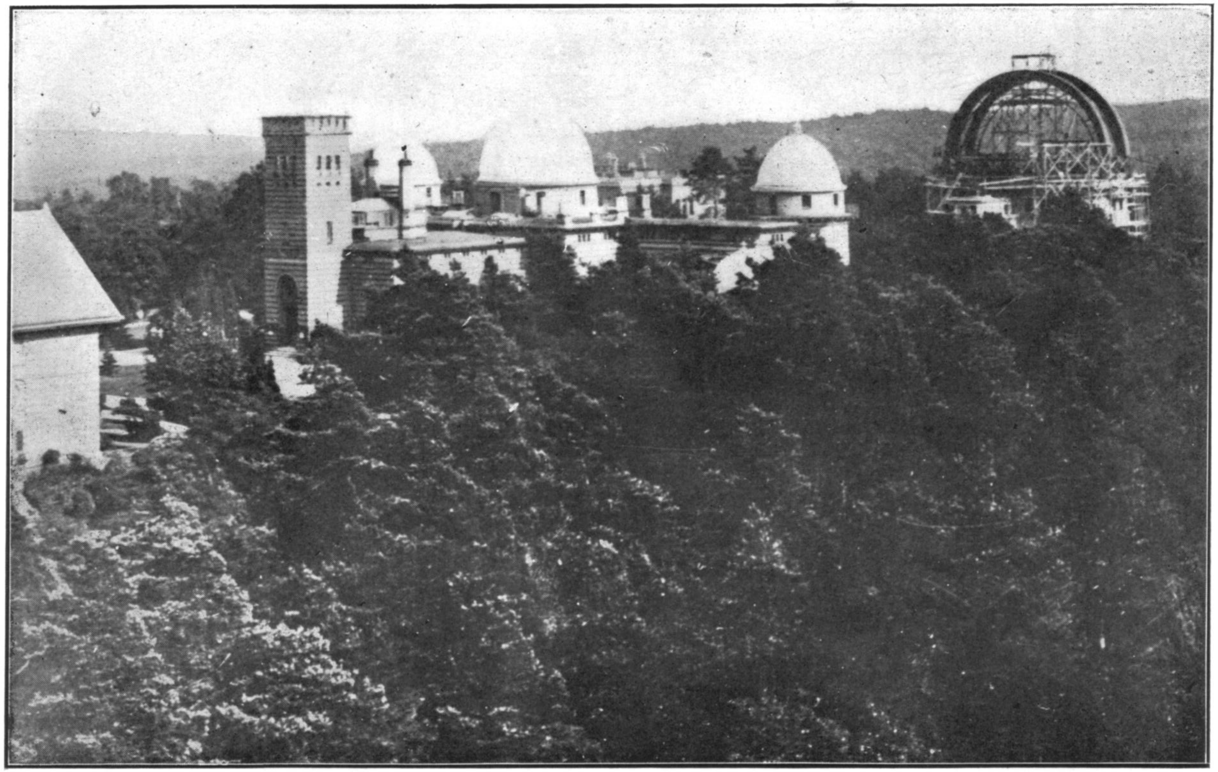
[1] An illustration showing the building after it was completed may be found in Volume XI (opposite page 215) of these Publications.



THE ASTROPHYSICAL OBSERVATORY, POTSDAM.

proximate position of 62,103 stars all lying in the zone 31° to 40° north declination. This work is not yet completed.

All of this work has been done under Professor Vogel's direction, and we can easily imagine that the administrative duties of such a large institution might fully absorb all of the energy of the director. Such, however, has not been the case, for Professor Vogel has found time to carry on scientific work, and has, altogether, published a large number of papers and memoirs on astronomical subjects. They have been printed mostly in the volumes of the Potsdam Observatory, in the *Sitzungsberichte* of the Berlin Academy of Sciences, in the *Astronomische Nachrichten*, and in the *Astrophysical Journal*. While looking up Doctor Vogel's writings I very soon became convinced that it would be quite out of the question for me, except by the expenditure of an amount of time impossible for me to give to the matter at present, to present to you anything more than a mere outline of his scientific activity. Fully half of the one hundred volumes of the *Astronomische Nachrichten* which have been issued since 1866 contain one or more articles by Doctor Vogel.

The*Astronomische Nachrichten* (volume 67) contains an article by Doctor Bruhns, Director of the Leipsic Observatory under date of July 1, 1866, in which are given some observations by Herr Vogel, and they constitute probably the first scientific observations made by our medalist. These consist of observations of minor planets, observations of a group of sun-spots, with drawings, and an account of some experiments made in photographing the Sun. It is seen that at this early date Doctor Vogel was interested in solar observation and in photography, and it should be remembered that photography was at that time in its infancy. While at Bothkamp (1870 to 1874) Doctor Vogel took up solar and spectroscopic work, and it was there, at a private observatory, that the first astrophysical work was done in Germany.

Although provided with only an 11½-inch refractor, a mere infant in comparison with the giant telescopes of the present day, yet the four years spent by Doctor Vogel at the Bothkamp Observatory were very prolific ones, and some of the most notable of the spectroscopic work was done during that time. The spectra of all classes of heavenly bodies were examined, but the most notable result of Doctor VOGEL's activity during this period is perhaps his observations of the spectra of the planets. The Copenhagen Academy of Sciences offered a prize for the best memoir on the spectra of the planets, and it was our medalist to whom this prize was awarded in 1874. Although these investigations were made over thirty years ago, and with a telescope of only 11½ inches aperture, still many of them have never been surpassed, and Doctor VOGEL's work is still quoted as authority on the spectra of the planets.

It was during this period also that he proposed a new classification of stellar spectra, which is, perhaps, more strictly speaking, a modification of SECCHI's classification. This is a very important subject, but time will not permit me to take up a detailed consideration of it. It is perhaps sufficient to state that although more elaborate systems of classification have been proposed, still the general classification laid down on broad lines by SECCHI and by VOGEL is still sufficient for most purposes.

The great activity of Doctor VOGEL at Bothkamp and the brilliant success attained there led to his selection as chief observer and afterwards director of the Astrophysical Observatory at Potsdam.

Among the many brilliant achievements of our medalist there is none perhaps which stands out more prominently than his observations of the velocities of the fixed stars in the line of sight. The principles underlying this method were explained to the members of this Society in a lecture by Professor CAMPBELL not very long ago, and as they have been explained frequently in astronomical journals it seems hardly necessary for me to repeat them here. It was in 1868 that Doctor HUGGINS first announced the method of determining velocities in the line of sight by measuring the displacement of the lines of the spectrum. This work was taken up by Doctor VOGEL while at the Bothkamp Observatory, and the radial velocities of some of the brighter stars, *Sirius, Procyon, Capella, Altair,* and *Vega,* were measured by visual methods, but it was not until Doctor VOGEL had at his disposal the finer equipment of the Potsdam Observatory that any great progress was made.

About the year 1887 he commenced experiments in photographing stellar spectra. By measuring the displacement of the lines, referred to a comparison spectrum on the same plate, it was found possible to determine these displacements to a much greater degree of accuracy than by visual methods, and also to measure the spectra of stars which, on account of their faintness, could not be reached by visual methods. In 1892 the results of this very important work were given to the world in part I of volume VII of the *Publications* of the Astrophysical Observatory. The velocity in the line of sight of fifty-one of the brightest stars of the sky was measured, and it was indeed a notable achievement. Since that time the work has been taken up at a number of places,—Pulkova, Meudon, Greenwich, Emerson McMillin, Yerkes, Lowell, and Lick observatories. The success of the Lick Observatory in this field of work is well known to members of this Society and need not be dwelt upon at this time. Many improvements have been made in the instrumental equipment with which this problem has been attacked, and a degree of refinement in the results has now been attained which probably far surpasses the wildest dreams of the originators of the method.

Several by-products have been obtained in the prosecution of this work, the most notable of which is the discovery of an entirely new species of double stars, the so-called spectroscopic binaries, dual systems in which one of the components, either on account of the relative faintness of its light or its proximity to a brighter star, or both, is invisible. This is an excellent example of the versatility of modern science, and it is indeed a notable achievement that astronomers should now possess methods of research that are capable of disclosing to us the existence of bodies situated at the confines of the universe and forever invisible in the most powerful telescopes. Our medalist shares with Professor PICKERING the honor of being the first to prove and announce the existence of such systems as these. It was in 1889 that Professor VOGEL announced that β *Persei* (*Algol*) and α *Virginis* (*Spica*) had invisible companions, which revolved with the bright stars around common centers of gravity; it was during the same year, and in fact shortly before Doctor VOGEL's announcement, that

Professor PICKERING announced that ζ *Ursae Majoris* (*Mizar*) and β *Aurigae* are attended by invisible companions, and thus it happened, as has been the case many times before, that an important discovery was announced almost simultaneously by two men working entirely independently of each other.

The discovery that *Algol* is attended by an invisible companion possessed a double interest from the fact that this discovery afforded an explanation of the peculiar type of variability exhibited by this star, and indeed confirmed an explanation, offered many years before, but based upon purely hypothetical considerations. The history of this star *Algol* has been written many times, but as the story is a very interesting one it will perhaps bear one more repetition. I shall, however, confine myself to a bare statement of the facts, without attempting to adorn my story with any of those embellishments that it would be a comparatively simple matter to provide. *Algol* at its normal brightness shines with almost the same amount of light as the Pole Star. That the brightness of *Algol* is at times considerably less than that of *Polaris* was first noticed by MONTANARI in 1669, but it was not until over a century later (1783) that GOODRICH discovered the exact nature of the variations of *Algol's* light and suggested an explanation. *Algol* remains at the same brightness most of the time, but at regular times of a little less than three days the light of the star begins to decrease and continues to decrease for about five hours, reducing the magnitude of the star from 2.2 to 3.7. The light then begins to increase again, and at the end of another five hours the normal brightness has been regained. Now, GOODRICH suggested that this diminution which takes place in the light of *Algol* might be caused by the interposition of a dark companion revolving around the star in a plane passing through our Sun, and therefore the bright star becomes partially eclipsed at regular intervals when the dark companion passes between *Algol* and the Earth. It follows, of course, that if such a dual system actually exists, the dark companion not only revolves around the bright star, but, conversely, the bright star revolves around the dark one, or, more correctly speaking, the two revolve around a common center of gravity, situated somewhere on the line joining their centers, midway between centers if the masses of the bodies are equal, but nearer the heavier one if the masses are unequal. It is therefore evident that *Algol* is revolving in an orbit, probably nearly circular, and, if the plane of this orbit passes through the Earth, then at one part of it *Algol* must be moving toward the Earth, half a period later moving away from the Earth, and at two other points will be moving in a direction perpendicular to the line joining *Algol* and the Earth. If this theory be correct, then it should be possible to detect, by means of the spectrograph, this change in the motion of *Algol* toward and from the Earth. Doctor VOGEL was the first person to undertake a solution of the problem, and his observations resulted in a complete verification of the theory. Before each minimum *Algol* was found to be moving away from the Sun at the rate of 42 kilometers (26 English miles) per second, and after each minimum to be approaching with an equal speed, while at intermediate times the imprinted lines showed no displacement, and hence the star was moving perpendicularly to the line joining *Algol* and the solar system. From these data, the known period of the variable, and the amount of obscuration caused by the passage of the dark companion, Doctor VOGEL was able to compute, on the assumption that the two bodies were of equal densities, the following results for this interesting variable spectroscopic binary:—

	Kilometers.		Miles.
Diameter of *Algol*	1,700,000	=	1,061,000
Diameter of the satellite..........	1,330,000	=	830,000
Distance between their centers...	5,180,000	=	3,230,000
Orbital velocity of *Algol*.........	42	=	26
Orbital velocity of the satellite....	89	=	55

Masses of the two bodies..four ninths and two ninths of the Sun's mass.

Doctor VOGEL has given much time to the study of the Sun, and the maps of the solar spectrum given in volume I of the *Publications* of the Astrophysical Observatory are perhaps the finest maps of the solar spectrum ever printed, and are almost universally used for purposes of instruction and illustration. Our medalist has given particular attention to the study of the spectra of new stars, and his memoirs on *Nova Aurigae* and *Nova Persei* occupy conspicuous places in the literature referring to these remarkable bodies. He has also studied the spectra of nebulæ, clusters, the Wolf-Rayet stars, comets, the aurora, the zodaical light, lightning; in fact, there is, I believe, no class of celestial bodies or celestial light phenomena that has not been studied by this indefatigable worker.

Doctor Vogel has devised many pieces of apparatus and improvements to spectroscopes. The observations made by him possess a high degree of precision, and many of the results obtained by him with small telescopes, in a rather poor climate from an astronomical standpoint, have not been surpassed by observers in possession of much more powerful instruments of research. I think it may truthfully be said that Professor Vogel has always obtained from his instruments the utmost that they were capable of yielding to him.

Many honors have been conferred upon Professor Vogel, but I have been unable to obtain a list of these. The gold medal of the Royal Astronomical Society was conferred upon him in 1893 for his "spectroscopic and other astronomical observations." Professor Vogel's published writings show him to be not only a keen observer, but also a man of rare judgment. His activity has led him into nearly every field of astronomical spectroscopy, not in a haphazard way, for we recognize in perusing his writings, that they are the products of a master mind.

I trust that this short, and I fear very inadequate, outline of the scientific activity of our medalist has been sufficient to show you the wisdom of your Board of Directors in selecting Professor Vogel, for this signal honor, from the list of eminent astronomers sent by the directors of the nominating observatories.

As San Francisco is far removed from the older centers of scientific activity, we have not yet been fortunate enough to have one of the Bruce Medalists with us. In the absence of Doctor Vogel, I hand to you, Mr. Secretary, this medal, a mark of the highest distinction that it is possible for this Society to bestow upon any astronomer, for transmission to the person whose name has been engraved upon it. You will kindly send with it the greetings of the members of the Astronomical Society of the Pacific, and especially of its Board of Directors, and our earnest wish that his life may be spared for many years in order that he may enjoy in the evening of life the well-earned fruits of great scientific activity.

March 31, 1906.